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The Associations of Multimorbidity with Health-related Productivity Loss in a Large and Diverse Public Sector Setting: A Cross-Sectional Survey

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Short Running Title

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Competing interests

The authors, Lili Wang, Fiona Cocker, Michelle Kilpatrick, Petr Otahal, Lei Si, Andrew J Palmer and Kristy Sanderson, declare that they have no competing interests.

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ABSTRACT

Objective: To evaluate absenteeism, presenteeism and total lost productive time (LPT) associated with multimorbidity.

Methods: Cross-sectional data from 3,228 state-government employees from Tasmania were collected in 2013. The validated measures of absenteeism, presenteeism and LPT were obtained from employees' self-reported data over a 28-day period. Analyses werestratified by sex.Negative binomial models were used to estimate the associations between multimorbidity and LPT.

Results: The average health-related total LPT was 1.2(SD=2.4) and 1.7(SD=3.5) days for men and women with multimorbidity, respectively. Women(RR=2.9, 95%CI 1.8-4.9) and men(RR=4.4, 95%CI 3.0-6.2) with 4+ chronic conditionswere significantly more likely to report LPT compared to those without any chronic conditions.

Conclusion: Wefound multimorbidity is of concern within the workforce, with apositive association of multimorbidity and LPT observed, and significant differences in LPT between men and women reporting multimorbidity.

Keywords: Multimorbidity; lost productive time; absenteeism; presenteeism

INTRODUCTION

More than 25% of the global population on average and the majority of people accessing primary care services have two or more chronic conditions[1]. Over half of adults aged 65 and over have three or more such conditions[2-4]. The prevalence of people with two or more chronic health conditions has increased steadily over the past decades worldwide. For example, in the Netherlands, the proportion of people with two or more chronic health conditions increased from 12.3% in 1985 to 20.5% in 2005 in primary care[5], while using the data from an America national household survey, the proportion increased from 21.8% in 2001 to 25.5% in 2012[6 7]. The burden of chronic health conditions is on the rise as the world's population ages and the prevalence of multiple health conditions (also known as multimorbidity) increases[8]. Multimorbidity has been linked in prior research to poorer health outcomes, and these studies mainly focused on patient or older populations[9-13]. However, the prevalence of multimorbidity in younger and healthier populations such as the working population[14] that accounts for 63.4% of adults worldwide[15], has not been well studied.

The costs of lost productivity from employees who are absent due to illness (also known as absenteeism) and employees who are present but perform below their normal level of effort due to health conditions (known as presenteeism) are substantial[16-18]. Research has indicated that chronic health conditions can reduce productivity[19]. Moreover, multimorbidity contributes to the complexity of investigating the associations between chronic health conditions and productivity loss[20-22]. To our knowledge, there are three studies have looked into the association between the number of concurrent chronic health conditions and productivityloss. A recent American multi-employer study reported that productivityloss increased concurrently with the number of chronic conditions and that the cost of this productivityloss was 1.3 times greater than direct health care costs[23]. Lenneman, Schwartz, Giuseffi, and Wang [24] adopted a list of five chronic health conditions to assess their relative contribution to productivity impairment rates and identified significant increases in lost productive time by the number of conditions in a large, diverse US employeeswho completed the online Health Risk Assessment. Mitchell and Bates[25] also used a large US data matched by actual medical claims with thirteen health conditions. These studies have demonstrated that having more health conditions can have substantial economic consequences since the health of workers affects their productivity at work.

Yet the approach of estimating lost productivity due to presenteeism and the populations studied varied across the multimorbidity-related studies. For example, one large cross-sectional study of approximately 78,000 working Australians measured presenteeism using a self-rated score of overall performance[26]. Another study, which combined lost days and productivity rate, was conducted in a relatively homogeneous working population[27]. Consequently, the results may not be generalisable to other populations. In addition, findings regarding sex on lost productivity have been inconsistent depending on the type of productivityloss. Women were generally more frequently to have more absenteeism than men but varies by different samples and duration[28]. While gender did not always show significant influence on presenteeism in literature[29-31]. For example, a study performed in the Netherlands reported that there was no association between men and women in the amount of lost productivity due to presenteeism[30]. By contrast, a US study estimating lifetime productivity found that the female workers had a smaller likelihood of labor productivity loss compared to their male counterparts[31]. The literature offers little insight into the relative importance of multimorbidity and the impact of sex on productivity loss.

To fill these data gaps, the present study analysed the associations of multimorbidity and absenteeism, presenteeism and total lost productivity in a large, diverse working population, and assessed the impact of sex on productivity loss due to multimorbidity.

METHODS

Study Population, Design and Setting

The study population, design and setting of Partnering Healthy@Work (PH@W) program has been described elsewhere[32 33].In brief, the Tasmanian State Service (TSS), whichemploys approximately 30,000 diverse public sector (government) employees across an estimated 1,500 Tasmanian worksites,conducted this programto improve the health and wellbeing of its entire workforce.Using a stratified random sample technique, 12,008 employees from all state government employees in Tasmania were selected and 3,228 responded by completing and returning their surveys. Self-report data from the 2013 pH@W survey were merged with administrative data from the TSS human resources database. Ethical approval for this researchwas obtainedfrom the Human Research Ethics Committee (Tasmania), reference no. H0010501.

Chronic Health Conditions

Twentychronic health conditions were identified from a pre-specified list from the World Health Organisation Health and Work Performance (WHO-HPQ) questionnaire[34], which includedarthritis or rheumatism, chronic back pain, migraine headaches, other frequent or severe headaches, any other chronic pain, high blood pressure or hypertension, congestive heart failure, coronary heart disease, stomach or intestinal ulcer, irritable bowel disorder, chronic heart burn or gastroesophageal reflux disease, asthma, chronic bronchitis or emphysema, chronic obstructive pulmonary disease, urinary or bladder problems, diabetes, osteoporosis, skin cancer, any other type of cancer and mental disorder. Respondents indicated (yes/no) whether they currently had each of the listed conditions or not.

Mental disorderswere identified using the Kessler Psychological Distress scale (K10), which has demonstrated validity and reliability[35], and is predictive of respondents meeting criteria for a diagnosable depression- or anxiety-related disorder[36]. Based on cut-points employed by the Australian Bureau of Statistics in population-based surveys, the total scores were grouped for analysis into ordered categories of low distress (K10 total score: 10-15), moderate distress (16-21), high distress (22-29) and very high distress (30-50)[37]. Respondents with high distress or very high distress were identified as having a high probability of mental disorder, and these data were then recoded to a binary variable (yes/no).

Using the count method, the employees then were assigned to one of five categories based on their total number of chronic conditions (0, 1, 2, 3, or 4 or more). Multimorbidity**(exposure)**was defined as the co-occurrence of two or more chronic health conditionsfrom these 20 pre-specified health conditions.Threerespondents wereexcluded from the analysis because they did not provide responses for any conditions.

Measures of ProductivityLoss

Lost productive time was measured using 3 brief items which have been validated in a previous study in 10 Australian workplaces[38]. Of them, one was about absenteeism which was from the Health and Work Performance Questionnaire (HPQ), while the other two were about presenteeism which consisted of a commonly used “number of days worked when ill” derived from Aronsson et al[39] and a visual analogue scale rating of perceived efficiency on presenteeism days[40].

This study investigated three outcomes: absenteeism, presenteeism and total lost productive time. Absenteeism was derived from the respondents' answers to the question, "How many days have you stayed away from your work because of the health problems?" during a four-week recall period (28 days). This approach has been validated when the recall duration is brief[41]. Presenteeism was defined as the working days while suffering from health problems and measured using the following two questions: "How many days did you go to work while suffering from health problems?" during the four-week recall period, and on these days, "what percentage of your time were you as productive as usual (on a scale from 0% to 100%)?", in which 0% was the worst job performance and 100% was the same performance as usual. This measure was calculated using the response data for number of lost days multiplied by lost productive rating. For example, if an employee experienced the effects of a health condition while at work for four lost days over the four-week recall periodand reported 60% job performance compared with his/her usual performance, the derived value for presenteeism was 1.6 days (Presenteeism=4*(1-0.6)).Total LPT was the sum of absenteeism days and presenteeism days.The four-week recall period was the continuous 28-days before the interview.

Statistical Analysis

All analyses were conducted for males and females separately based on prior research suggesting sex differences in LPT. To address the possibility of response bias, the inverse probability of response weighting method described elsewhere was used[42-44]. Unweighted proportions and means with standard deviations (SDs) were used to summarise the data. The LPT estimates were all count variables ranging from 0 to 28 days, therefore, negative binomial models were appropriate to investigate the associations of the predictors with the outcomes (the lost days due to presenteeism, absenteeism or total LPT) over the previous four weeks.

Covariates were identified using the regression modelling techniques described by Hosmer Jr, Lemeshow, and Sturdivant [45].Univariate analyses with a 0.25 p-value cut-off were performed to screen the covariates before the second round of screening, which involved multivariate analyses. A cut-off of a 10% change in the exposure variable's coefficient estimate in the multivariate model was adopted to select variables influencing the association between outcome and exposure. The covariates that remained following these procedures were utilised throughout all the subsequent analyses conducted in this study. Given that there were three outcomes and that the sample was stratified by sex, the covariates for each model varied (covariates listed in Table 1).

The statistical significance of the regression coefficients was tested usinga two-tailed p-value of <0.05. Rateratios (RRs) are reportedwith 95% confidence intervals (CIs). All the analyses were performed using Stata/CI Version 14.1 (StataCorp, College Station, TX, USA).

RESULTS

The characteristics of the 3,086 2013 pH@W respondents included in analyses are reported in Table 1. Respondents were excluded when their lost productive days due to absenteeism or presenteeism were missing (n=139); however, if only the lost productivity rating item was missing, a mean value was imputed for this variable (n=3). The mean age for both males and females was 47 years (SD=10), and the majority of the respondents were female (71.7%). Most of the male and female respondents (84.2%; 74.1%) were married and a majority had university or postgraduate level education (57.1%; 54.5%). Most males (84.8%) were employed full time, whereas approximately half of the females (52.2%) were employed part time or casually. These characteristics were reflective of the Tasmanian State Service workforce as a whole. More than one in three employees had multimorbidity (31.2% for males and 37.8% for females). (Table 1)

Table 2 presents the unweighted participant characteristics for the 3,086 respondents by four-week absenteeism and presenteeism (1+ days) and the univariate associations by characteristics and sex in the 2013 pH@W survey of TSS employees. Female workers reporting more health conditions were more likely to report absenteeism and presenteeism. For both sexes, more respondents reported presenteeism than absenteeism in all the characteristics groups. The respondents with multimorbidity and poor/fair self-reported health status were more likely to report absenteeism or presenteeism than those without multimorbidity who reported good/very good/excellent health status. Moreover, the RRs for absenteeism and presenteeism for both sexes increased as the number of chronic health conditions increased.

The range of the mean age for all four sample groups (stratified by absenteeism and presenteeism (1+ days) and by sex) was 44.8 years (SD=10.8) for women with absenteeism to 47 years (SD=10.1) for men with absenteeism (results not shown in table). The range of the mean BMI for all four sample groups was 27.3 kg/m^2(SD=4.3) for men with presenteeism to 28.0 kg/m^2 (SD=4.5) for men with absenteeism. Women had a higher mean number of chronic health conditions than men within the absenteeism and presenteeism behavior groups (absenteeism: women 2.0 vs. men 1.6; presenteeism: women 2.2 vs. men 1.8).

The respondents with more chronic conditions had more days of lost productivity (absenteeism, presenteeism and total lost productivity). The number of lost absenteeism days was greater than the number of lost presenteeism days for both sexes. The mean of total lost productivity due to health problems was1.2days (SD=2.4) and 1.7days (SD=3.5) for men and women with multimorbidity, respectively. (Table 3)

Table 4provides estimated rate ratios for the days of lost productivity (absenteeism, presenteeism and both) over four-week period by multimorbidity and by sex. All model estimates were adjusted for confounders including age, BMI, education level, marital status, smoking status, self-reported health status, occupational type, employment condition and annual salary. Compared to those without multimorbidity, both sexes with multimorbidity were more likely to have more absenteeism/presenteeism/total productive lost days.

Table 5 provides the estimated rate ratios for the lost days of absenteeism/presenteeism/total lost productive days over four-week period by the number of chronic health conditions and by sex. Model estimates were adjusted for selected confounders as described in the Methods including age, BMI, education level, marital status, smoking status, self-reported health status, occupational type and annual salary. Female employees had more lost days than male employees when suffering from chronic conditions, compared to those without any chronic conditions. Employees were more likely to have more presenteeism lost days due to health problems than absenteeism lost days when suffering from chronic conditions, particularly in female employees. Male employees did not have more lost days until having four or more chronic conditions, when they had 2.6 times more absenteeism lost days (adjusted RR = 2.6, 95% CI 1.4, 4.8) in comparison to male employees without any chronic conditions. When combining absenteeism and presenteeism lost days, the increasing number of chronic conditions were still associated with more lost productive days in both sexes. The increasing pattern of more lost productivetime as the number of chronic conditions increased was marked in female employees; in male employees, those with four and more conditions had the greatest lost productivity due to absenteeism/ presenteeism/total lost productivity compared to those with less than four conditions.

DISCUSSION

This study examined the associations of multimorbidity with LPT (absenteeism, presenteeism and total LPT) in a cross-sectional sample of working adults and found a positive relationship between the presence of multimorbidity and the number of productive loss days for both sexes. Employees with more chronic conditions had more lost productive days. Female employees had a greater risk of either absenteeism, presenteeism or total LPT when suffering from multimorbidity than those without multimorbidity. However, a greater number of chronic conditions was associated with a significantly increased risk of lost productive days in female employees compared to male employees. These findings suggest the strong relationship between multimorbidity and productive lost days, particularly those with four or more chronic conditions. Although the literature on multiple chronic conditions and lost productivity is relatively sparse and with different focuses, these findings contribute to the growing body of evidence of the effect of multimorbidity on lost productivity.

In contrast to an earlier Australian study of the associations between individual health conditions and productivity loss, which found that health conditions have a greater impact on performance while at work than on absenteeism[26], we found that more days were lost due to absenteeism than due to presenteeism for both sexes when the respondents were suffering from multimorbidity.The workers with multimorbidity tend to have worse health than those with a single disease, thenthey would require more days off to, for example, get medical treatments or more rest, rather than working while sick.

The findings of this study that women had slightly more days lost than men due to health problems supported there was the gender difference in the association between multimorbidity and LPT. The multivariate regressions demonstrated a statistically significant difference between the sexes for days lost due to multimorbidity between sexes. In studies of the general population, the prevalence of multimorbidity was higher in females than in males[46-48], and our study, in which there 31% of male and 38% of female employees reported having multimorbidity, was consistent with these previous findings. The overall prevalence of multimorbidity in this working population was 36%, which was higher than the estimates reported for the Australian general population (20%)[49] and general working population (23%). It is likely that this discrepancy is large because the current respondents were mostly females (71%) and older (47 year-old) than the other populations (37 year-old in general population and 40 year-old in general working population, from 2011-12 Australian National Health Survey[50]).

On one hand, older employees are obviously more likely to experience higher numbers of health conditions; on the other hand,it is also possible that the results could be explained by gender role, conflict and strain[51]. Males are more likely to ignore their bodies' "unwell" signals and refuse to admit the negative impact of health conditions on their life, which is related to an unwillingness to exhibit their helplessness or vulnerability to others[51]. Females, however, do not have this "femininity" fear, which may result in more lost productive days among females. Females began exhibiting lower productivity at work with only one chronic condition. In addition, compared to females, males prefer to express their unique attributes in relation to their work[52 53], and this encourages males to continue working while sick but deny the negative influence of health problems on their work performance. Nevertheless, multimorbidity weakens the difference between sexes in lost productive behavior. Co-occurrence of presenteeism and absenteeism in the same employees[54] was found in both sexes with multimorbidity in our study. Again, female employees were more likely to lose more productive days due to health problems compared to their counterparts.

Certain limitations and considerations should be taken into account when interpreting our results. First, this survey does not limit the measurement of productivity loss to only the pre-specified health conditions; therefore, employees may also have reported productivity loss due to other health problems. Second, recall bias may be present because of the use of questionnaire-based, self-reported data. The productivity loss rate is captured through the employees' self-reported responses, and the employees are in a better position than the researchers to recognise the working performance that are most relevant to their particular occupations, to evaluate their recent performance in these domains, and to arrive at a rating of their overall work performance based on this evaluation. Moreover, the employees' self-reported days lost were validated externally and found to be consistent with the employers' reported days lost from previous studies[41].

Third, this study obtained cross-sectional data in 2013; therefore, the direction of causality cannot be explored, and the results may only reflect short-term (4-week) behavior of employees and the associations of multimorbidity on that behaviour. This reduces the potential for recall bias for the self-reported questionnaire[55] as the absenteeism or presenteeism behavior of employees may change over time. However, this cannot be proven with cross-sectional data and requires further investigation using longitudinal data. For this reason, we presented the results as they were, unlike one study that annualized the same duration measures to reflect an entire work year[23]. Some other questionnaires,for example, the validated Work Productivity Loss and Activity Impairment (WPAI) questionnaire[56 57],used ashorter time period (7-day) to capture productivity loss. We acknowledge that recall may be more accurate for a 7-day versus a 28-day measure, however previous research suggests our measure has good concordance with other validated measures and is sensitive to change[38].

Fourth, it is important to note that respondents tend to underestimate the impact of diseases on their productivity as the length of time they are asked to recall increases[55]. As with any study that asks participants to recall past events, recall bias may be evident. However, the survey's focus on frequency of productivity loss due to illness may have reduced the potential for bias[58]. Finally, the used survey does not account for workers coming in early or leaving late on other days to make up for hours of missed work. Additionally, we surveyed a sample of TSS employees that is not fully representative of the total workforce. Moreover, pH@W did not measure selection bias or confounding due to factors and used a short and simple measure to identify health conditions.

The approach we used to capture presenteeism is the employees' self-reported performance scales. Therefore, the results can easily be quantified and incorporated into a monetisation formula that could be used in cost-related studies of multimorbidity, such as cost-of-illness studies estimating the economic burden of eliminating multimorbidity and cost-effectiveness studies of evidence-based and cost-effective efforts to manage multimorbidity. Moreover, some workplace health promotion programshave been found that could positively affect presenteeism as well as absenteeism[59-61], while the major challenge are still the uncertainty of the working participation and behaviour change over time[28 59]. Further research in which collecting long-term LPT is needed.

CONCLUSION

More than a third of men and women in this comparatively healthy working population experienced multimorbidity. Our study provides insight into the adverse associations of multimorbidity on workplace productivity in public sector employees, helps employers realize the value of maintaining a healthy working population, and can be considered by employers as they develop health benefits and preventive health care intervention strategies. Further programs that reduce absenteeism[59] andpresenteeism may have financial benefits for stakeholders including employees, employees' family, and employers across different workplace settings. Moreover, female employees require greater attention, particularly those with multimorbidity.

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Table 1 Study characteristics by sex in the Partnering Healthy@Work (pH@W) survey of Tasmanian State Service employees conducted in 2013. (N=3,086).

	Men		Women	
	n	**%**	**n**	**%**
Total	874	28.3	2,212	71.7
Age (years), mean (Standard Deviation (SD))	47 (10)		47 (10)	
Age group (years)				
<30	57	6.5	172	7.8
30-39	139	15.9	373	16.9
40-49	247	28.3	630	28.5
50-59	341	39.0	876	39.6
60+	90	10.3	161	7.3
Education				
<=Year 12	140	16.0	428	19.3
Trade/certificate/diploma	235	26.9	575	26.0
University	277	31.7	721	32.6
Postgraduate	222	25.4	484	21.9
Marital status				
Married/living as married	734	84.2	1,638	74.1
Separated/widowed/single	138	15.8	566	25.9
BMI (kg/m^2)				
Under/normal (BMI <25 kg/m^2)	295	33.8	920	41.6
Overweight (BMI 25-29.9 kg/m^2)	384	43.9	577	26.1
Obese (BMI >= 30 kg/m^2)	173	19.8	452	20.4
Self-reported health status				
Good/very good/excellent	761	87.1	1,936	87.5
Poor/fair	111	12.7	273	12.3
Smoking status				
Ex-smoker/never	805	92.1	1,993	90.1
Current	67	7.7	209	9.4
Occupational type				
Blue collar	135	15.4	367	16.6
Manager	180	20.6	132	6.0
White collar	230	26.3	678	30.7
Service	286	32.7	975	44.1
Professional	27	3.1	44	2.0
Employment condition				
Full-time work	741	84.8	1,058	47.8
Part-time work/Casual	133	15.2	1,154	52.2
Annual salary				
<$55,000	133	15.2	580	26.2
$55,000–$64,999	100	11.4	326	14.7
$65,000–$74,999	166	19.0	447	20.2
$75,000–$84,999	171	19.6	538	24.3

>$85,000	304	34.8	321	14.5
Number of chronic health conditions				
0	386	44.2	783	35.4
1	215	24.6	593	26.8
2	147	16.8	406	18.4
3	68	7.8	215	9.7
4+	58	6.6	215	9.7
MM2+				
No	601	68.8	1,376	62.2
Yes	273	31.2	836	37.8

BMI, Body Mass Index, MM2+, the co-occurrence of two or more chronic health conditions (multimorbidity 2+).

Table 2 Prevalence of absenteeism and presenteeism (1+ days) and univariate associations by study characteristics and by sex. (N=3,086).

	Absenteeism(1+ days)[a]				**Presenteeism(1+ days)[b]**			
	Men		**Women**		**Men**		**Women**	
	n (%)	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**	**n (%)**	**PR (95% CI)**
Total	176 (20.1)		555 (25.1)		273 (31.2)		817 (36.9)	
Age group (years)								
<30	9 (15.8)	1.0	59 (34.3)	1.0	14 (24.6)	1.0	64 (37.2)	1.0
30-39	29 (20.9)	1.4 (0.7-2.9)	116 (31.1)	0.9 (0.7-1.2)	56 (40.3)	**2.1** (**1.2-3.7**)	154 (41.3)	1.1 (0.9-1.4)
40-49	57 (23.1)	1.5 (0.7-2.9)	159 (25.2)	**0.7** (**0.6-1.0**)	95 (38.5)	**1.9** (**1.1-3.3**)	253 (40.2)	1.1 (0.9-1.3)
50-59	64 (18.8)	1.3 (0.7-2.6)	189 (21.6)	**0.6** (**0.5-0.8**)	90 (26.4)	1.4 (0.8-2.5)	303 (34.6)	0.9 (0.7-1.1)
60+	17 (18.9)	1.2 (0.6-2.6)	32 (19.9)	**0.6** (**0.4-0.9**)	18 (20.0)	1.1 (0.5-2.1)	43 (26.7)	**0.7** (**0.5-1.0**)
Education								
<=Year 12	28 (20.0)	1.0	106 (24.8)	1.0	39 (27.9)	1.0	152 (35.5)	1.0
Trade/certificate/diploma	46 (19.6)	0.9 (0.6-1.4)	152 (26.4)	1.1 (0.9-1.3)	75 (31.9)	1.1 (0.8-1.5)	237 (41.2)	1.2 (1.0-1.4)
University	69 (24.9)	1.2 (0.8-1.8)	179 (24.8)	1.0 (0.8-1.3)	96 (34.7)	1.3 (0.9-1.8)	260 (36.1)	1.0 (0.9-1.2)
Postgraduate	33 (14.9)	0.7 (0.5-1.2)	117 (24.2)	0.9 (0.7-1.2)	63 (28.4)	1.0 (0.7-1.4)	165 (34.1)	1.0 (0.8-1.2)
Marital status								
Married/living as married	146 (19.9)	1.0	378 (23.1)	1.0	227 (30.9)	1.0	570 (34.8)	1.0
Separated/widowed/single	30 (21.7)	1.0 (0.7-1.5)	175 (30.9)	**1.4** (**1.2-1.6**)	46 (33.3)	1.0 (0.8-1.3)	244 (43.1)	**1.3** (**1.1-1.4**)

BMI (kg/m^2)								
Under/normal (BMI <25 kg/m^2)	46 (15.6)	1.0	202 (22.0)	1.0	87 (29.5)	1.0	292 (31.7)	1.0
Overweight (BMI 25-29.9 kg/m^2)	78 (20.3)	1.2 (0.9-1.7)	127 (22.0)	1.0 (0.8-1.2)	121 (31.5)	1.1 (0.9-1.4)	212 (36.7)	**1.2** (**1.0-1.4**)
Obese (BMI >= 30 kg/m^2)	47 (27.2)	**1.6 (1.1-2.3)**	153 (33.9)	**1.6 (1.3-1.9)**	58 (33.5)	1.1 (0.8-1.5)	210 (46.5)	**1.5** (**1.3-1.7**)
Self-reported health status								
Good/very good/excellent	133 (17.5)	1.0	440 (22.7)	1.0	205 (26.9)	1.0	639 (33.0)	1.0
Poor/fair	41 (36.9)	**1.9** (**1.4-2.6**)	114 (41.8)	**1.8** (**1.5-2.2**)	66 (59.5)	**2.2 (1.8-2.7)**	177 (64.8)	**2.0** (**1.8-2.2**)
Smoking status								
Ex-smoker/never	162 (20.1)	1.0	487 (24.4)	1.0	245 (30.4)	1.0	723 (36.3)	1.0
Current	13 (19.4)	0.9 (0.6-1.6)	65 (31.1)	1.2 (1.0-1.5)	27 (40.3)	1.3 (1.0-1.8)	89 (42.6)	1.2 (1.0-1.4)
Occupational type								
Blue collar	31 (17.2)	1.0	31 (23.5)	1.0	42 (23.3)	1.0	61 (46.2)	1.0
Manager	32 (23.7)	0.7 (0.5-1.2)	113 (30.8)	**0.7 (0.5-1.0)**	44 (32.6)	0.8 (0.5-1.1)	137 (37.3)	1.2 (1.0-1.5)
White collar	45 (19.6)	0.8 (0.5-1.2)	174 (25.7)	**0.8 (0.6-1.0)**	67 (29.1)	0.8 (0.6-1.2)	271 (40.0)	1.0 (0.9-1.2)
Service	65 (22.7)	0.9 (0.6-1.4)	226 (23.2)	**0.7 (0.6-0.9)**	108 (37.8)	1.1 (0.9-1.5)	327 (33.5)	0.9 (0.8-1.0)
Professional	1 (3.7)	**0.1** (**0.0-0.3**)	7 (15.9)	0.5 (0.3-1.1)	6 (22.2)	0.8 (0.3-1.7)	17 (38.6)	1.0 (0.7-1.6)
Employment condition								
Full-time work	152 (20.5)	1.0	294 (27.8)	1.0	237 (32.0)	1.0	427 (40.4)	1.0
Part-time work/Casual	24 (18.1)	0.8 (0.6-1.2)	261 (22.6)	**0.8** (**0.7-0.9**)	36 (27.1)	0.8 (0.6-1.1)	390 (33.8)	**0.8** (**0.8-0.9**)
Annual salary								

<$55,000	27 (20.3)	1.0	154 (26.6)	1.0	38 (28.6)	1.0	214 (36.9)	1.0
$55,000–$64,999	25 (25.0)	1.2 (0.7-2.0)	81 (24.9)	0.9 (0.7-1.2)	38 (38.0)	1.4 (0.9-2.0)	132 (40.5)	1.1 (0.9-1.3)
$65,000–$74,999	40 (24.1)	1.3 (0.8-2.0)	129 (28.9)	1.1 (0.9-1.3)	54 (32.5)	1.3 (0.9-1.8)	162 (36.2)	1.0 (0.8-1.1)
$75,000–$84,999	35 (20.5)	1.1 (0.7-1.7)	117 (21.8)	**0.8 (0.6-1.0)**	63 (36.8)	1.3 (0.9-1.9)	179 (33.3)	0.9 (0.8-1.1)
>$85,000	49 (16.1)	0.8 (0.5-1.3)	74 (23.1)	0.8 (0.6-1.1)	80 (26.3)	1.0 (0.7-1.5)	130 (40.5)	1.1 (0.9-1.3)
Number of chronic health conditions								
0	59 (15.3)	1.0	144 (18.4)	1.0	76 (19.7)	1.0	149 (19.0)	1.0
1	45 (20.9)	1.2 (0.9-1.8)	120 (20.2)	1.1 (0.9-1.4)	57 (26.5)	1.3 (0.9-1.7)	194 (32.7)	**1.8 (1.5-2.2)**
2	30 (20.4)	1.3 (0.9-2.0)	114 (28.1)	**1.5 (1.2-1.9)**	69 (46.9)	**2.3 (1.8-3.0)**	182 (44.8)	**2.4 (2.0-2.9)**
3	17 (25.0)	**1.7 (1.0-2.7)**	74 (34.4)	**1.8 (1.4-2.3)**	34 (50.0)	**2.5 (1.8-3.4)**	126 (58.6)	**3.1 (2.5-3.7)**
4+	25 (43.1)	**2.5 (1.7-3.8)**	103 (47.9)	**2.6 (2.1-3.2)**	37 (63.8)	**3.1 (2.3-4.1)**	166 (77.2)	**4.1 (3.5-4.9)**
MM2+								
No	104 (17.3)	1.0	264 (19.2)	1.0	133 (22.1)	1.0	343 (24.9)	1.0
Yes	72 (26.4)	**1.6 (1.2-2.0)**	291 (34.8)	**1.8 (1.6-2.1)**	140 (51.3)	**2.3 (1.9-2.8)**	474 (56.7)	**2.3 (2.0-2.5)**

BMI, Body Mass Index; MM2+, the co-occurrence of two or more chronic health conditions (multimorbidity 2+); PR (95%CI) = prevalence ratio (95% confidence interval).Bold p values are statistically significant ($p < 0.05$).

a: number of days reported absent from work over a four-week period.

b: number of days reported present at work but suffering from health problems over a four-week period.

Table 3 Mean of the lost productivity days (0+ days) by different levels of chronic health conditions (number & MM2+) by sex.

Different levels of chronic health conditions	n	Days lost due to absenteeism[a] Mean	Days lost due to absenteeism[a] SD	Days lost due to presenteeism[b] Mean	Days lost due to presenteeism[b] SD	Total productivity lost days[c] Mean	Total productivity lost days[c] SD
Men (N=874)	874	0.6	2.0	0.2	0.9	0.8	2.3
Number							
0	386	0.4	1.6	0.1	0.5	0.5	1.7
1	215	0.7	2.6	0.2	1.0	0.9	3.0
2	147	0.7	2.2	0.3	0.9	1.0	2.4
3	68	0.5	1.0	0.5	1.3	1.0	1.8
4+	58	1.3	2.6	0.7	1.1	2.0	2.9
No MM2+	601	0.5	2.0	0.2	0.7	0.6	2.2
Yes MM2+	273	0.8	2.1	0.4	1.1	1.2	2.4
Women (N=2,212)	2,212	0.7	2.4	0.3	0.9	1.0	2.7
Number							
0	783	0.4	1.3	0.1	0.4	0.5	1.4
1	593	0.5	2.0	0.3	0.8	0.8	2.3
2	406	0.8	2.6	0.4	0.9	1.2	2.8
3	215	0.9	2.3	0.5	1.3	1.4	2.9
4+	215	2.0	4.5	0.9	1.7	2.9	4.8
No MM2+	1,376	0.5	1.6	0.2	0.6	0.6	1.8
Yes MM2+	836	1.1	3.2	0.5	1.3	1.7	3.5

MM2+, the co-occurrence of two or more chronic health conditions (multimorbidity 2+); SD, standard deviation.

a: number of days reported absent from work over a four-week period

b: number of days reported present at work but suffering from health problems over a four-week period.

c: number of total amount of days reported absent from work an d present at work but suffering from health problems over a four-week period.

Table 4 Multivariate associations between the productivity lost days and multimorbidity by sex.

		Men RR (95%CI)	Women RR (95%CI)
Days lost due to absenteeism[a]		n=856	n=1,917
	No MM2+	1.0	1.0
	Yes MM2+	1.6 (1.0-2.4) P=0.058	**2.2 (1.8-2.9)**
Days lost due to presenteeism[b]		n=852	n=2,198
	No MM2+	1.0	1.0
	Yes MM2+	**3.1 (1.9-5.1)**	**2.8 (2.2-3.7)**
Total lostproductivity days[c]		n=858	n=1,931
	No MM2+	1.0	1.0
	Yes MM2+	**1.8 (1.3-2.6)**	**2.4 (1.9-3.0)**

MM2+, the co-occurrence of two or more chronic health conditions (multimorbidity 2+); RR (95%CI) = rate ratio (95% confidence interval).Bold p values are statistically significant (p <0.05).

a: number of days reported absent from work over a four-week period. Men: adjusted for education level, self-reported health status, occupational type, age, annual salary. Women: adjusted for education level, marital status, smoking status, self-reported health status, occupational type, age, BMI.

b: number of days reported present at work but suffering from health problems over a four-week period. Men: adjusted for age, employment condition, self-reported health status, smoking status.Women: adjusted for education level, marital status, BMI, self-reported health status, annual salary, employment condition, age.

c: number of total amount of days reported absent from work and present at work but suffering from health problems over a four-week period. Men: adjusted for education level, age,annual salary,self-reported health status, occupational type. Women: adjusted for education level, marital status, smoking status, self-reported health status, occupational type, employment condition, age, BMI.

Table 5 Multivariate associations between the total lost days due to absenteeism/presenteeism/total lost productivity and number of chronic health conditions by sex.

Number of chronic health conditions		**Absenteeism**		**Presenteeism**		**Total lost productivity**
	n	**RR (95%CI)[a]**	**n**	**RR (95%CI)[c]**	**n**	**RR (95%CI)[e]**
Men		**N=856**		**N=870**		**N=856**
0	381	1.0	385	1.0	381	1.0
1	211	1.8 (1.0-3.3)	214	1.7 (0.9-3.5)	211	**1.8 (1.1-3.1)**
2	140	1.8 (0.9-3.7)	146	**2.7 (1.3-5.4)**	140	**2.1 (1.2-3.6)**
3	67	1.2 (0.6-2.2)	68	**3.9 (1.9-8.2)**	67	**1.9 (1.1-3.2)**
4+	57	**2.6 (1.4-4.8)**	57	**3.9 (2.0-7.8)**	57	**2.9 (1.8-4.9)**
P for trend		**P<0.05**		**P<0.0001**		**P<0.0001**
	n	**RR (95%CI)[b]**	**n**	**RR (95%CI)[d]**	**n**	**RR (95%CI)[f]**
Women		**N=1,917**		**N=1,939**		**N=1,917**
0	680	1.0	689	1.0	680	1.0
1	507	1.2 (0.8-1.8)	511	**2.7 (1.8-4.1)**	507	**1.5 (1.1-2.1)**
2	357	**2.2 (1.4-3.3)**	361	**3.8 (2.5-5.8)**	357	**2.5 (1.8-3.5)**
3	185	**2.2 (1.4-3.4)**	187	**5.2 (3.3-8.4)**	185	**2.8 (1.9-4.0)**
4+	188	**3.6 (2.2-5.7)**	191	**7.6 (4.9-11.8)**	188	**4.4 (3.0-6.2)**
P for trend		**P<0.001**		**P<0.0001**		**P<0.0001**

RR (95%CI) = rate ratio (95% confidence interval).

a: number of days reported absent from work over a four-week period. Men: adjusted for education level, self-reported health status, occupational type, age, annual salary.

b: number of days reported absent from work over a four-week period. Women: adjusted for education level, marital status, smoking status, self-reported health status, occupational type, age, BMI.

c: number of days reported present at work but suffering from health problems over a four-week period. Men: adjusted for age, employment condition, self-reported health status, smoking status.

d: number of days reported present at work but suffering from health problems over a four-week period. Women: adjusted for education level, marital status, BMI, self-reported health status, annual salary, employment condition, age.

e: number of total amount of days reported absent from work and present at work but suffering from health problems over a four-week period. Men: adjusted for education level, age,annual salary,self-reported health status, occupational type.

f: number of total amount of days reported absent from work and present at work but suffering from health problems over a four-week period. Women: adjusted for education level, marital status, smoking status, self-reported health status, occupational type, employment condition, age, BMI.